STATEMENT

I, Yoshikazu SAKA, residing at Ark Mori Building 13F, 12-32, Akasaka 1-chome, Minato-ku, Tokyo 107-6013, Japan hereby state that I have a thorough knowledge of the English and Japanese languages and that the attached documents are accurate English translations of the Priority Certificates of Japanese Patent Application Nos.2000-377405 and 2000-377406 both filed December 12, 2000 upon which the present U.S. patent application (USSN 10/006,648) claims a priority.

Date: November 3, 2005

Yoshikazu SAKA

JAPAN PATENT OFFICE

This is to certify that the annexed is a true copy of the following application as filed with this office.

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Application Number: Japanese Patent Application No. 2000-377405

Applicant(s): PIONEER CORPORATION

September 28, 2001

Commissioner,

Patent Office: Kozo OIKAWA

(Seal)

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[List of Attached Documents]

[Article]	Specification	1
[Article]	Drawings	1
[Article]	Abstract	1
[General Power of Attorney No.]	9102133	

[Request for Proof] Yes

[Designation of Document] SPECIFICATION

[Title of the Invention] Film forming apparatus and film forming method

[Claims]

[Claim 1] A film forming apparatus comprising:

rotating means for rotating a substrate; and

a film forming jig to be placed on said substrate, the film forming apparatus characterized in that:

a film is formed on said substrate by rotating said rotating means under a state where film forming liquid is supplied so as to be in contact with an outer periphery of said film forming jig.

[Claim 2] The film forming apparatus according to claim 1, characterized in that said film forming jig has a substantially cylindrical shape.

[Claim 3] The film forming apparatus according to claim 1, characterized in that said film forming jig has a substantially conical shape.

[Claim 4] The film forming apparatus according to claim 1, characterized in that said film forming jig has a substantially truncated conical shape.

[Claim 5] A film forming method characterized by comprising:

a step of placing a film forming jig on a substrate;

a step of supplying film forming liquid so as to be in

contact with an outer periphery of said film forming jig; and

a step of rotating said substrate.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention Belongs]

The present invention relates to a film forming apparatus and a film forming method in which a film can be formed while controlling the thickness of the film.

[0002]

[Conventional Art]

As a method of forming such a layer, known is a method using a spin coater. In the method, an ultraviolet curing resin is dropped on an optical disc substrate which is placed on a turntable, and the optical disc substrate is then rotated at a high speed by the turntable, whereby the ultraviolet curing resin is spread over the entire face of the optical disc substrate. This method is advantageous from the viewpoint of the production cost, because a resin which is spun off from the spin coater can be reused.

[0003]

[Problems that the Invention is to Solve]

In an optical disc substrate, an opening is formed in the center. Therefore, there arises a problem in that it is difficult to form a uniform cover layer because of the

positional relationship between the position to which an ultraviolet curing resin is supplied and that where the cover layer is formed. That is, there is a problem in that when the ultraviolet curing resin is dropped in the inner peripheral area of the substrate and then spun off by high-speed rotation, the film thickness distribution of the ultraviolet curing resin is formed so as to be thin in the inner peripheral area and thick in the outer peripheral area. When the resin dropping position is moved to a further inward position in order to uniformalize the film thickness, there arises other problems such as that the resin leaks through the opening of the optical disc substrate to soil the turntable.

[0004]

It is an object of the invention to provide a film forming apparatus and a film forming method in which a film can be formed while controlling the thickness of the film.

[0005]

[Means for Solving the Problems]

A film forming apparatus according to the invention includes rotating means (1) for rotating a substrate (3); and a film forming jig (2) to be placed on the substrate (3), the film forming apparatus characterized in that a film (4A) is formed on the substrate (3) by rotating the rotating means (1) under a state where film forming liquid

(4) is supplied so as to be in contact with an outer periphery of the film forming jig (2).

[0006]

In the film forming apparatus, since the rotating means is rotated under a state where the film forming liquid is supplied so as to be in contact with the outer periphery of the film forming jig placed on the substrate, the difference in film thickness between inner and outer peripheral sides of the substrate can be controlled, so that, for example, a uniform film thickness is obtained over the entire area.

[0007]

The film forming jig (2) may have one of a substantially cylindrical shape (2), a substantially conical shape (22), and a substantially truncated conical shape (21, 23).

[0008]

A film forming method according to the invention is characterized by including a step of placing a film forming jig (2) on a substrate (3); a step of supplying film forming liquid (4) so as to be in contact with an outer periphery of the film forming jig (2); and a step of rotating the substrate (3).

[0009]

According to the film forming method, since the

rotating means is rotated under a state where the film forming liquid is supplied so as to be in contact with the outer periphery of the film forming jig placed on the substrate, the difference in film thickness between inner and outer peripheral sides of the substrate can be controlled, so that, for example, a uniform film thickness is obtained over the entire area.

[0010]

It is noted that although reference numerals in the accompanying drawings are appended with parentheses for the sake of easily understanding, this does not limit the invention to embodiments shown in the drawings.

[0011]

[Mode for Carrying Out the Invention]

-First embodiment-

Hereinafter, a first embodiment of the film forming apparatus of the invention will be described with reference to Figs. 1 and 2. Fig. 1(a) is a section view showing the film forming apparatus of the first embodiment, Fig. 1(b) is a partial enlarged view of Fig. 1(a), Fig. 2(a) is a plan view of a ring as viewed from the top of Fig. 1, and Fig. 2(b) is a section view taken along line B-B of Fig. 2(a).

[0012]

As shown in Figs. 1 and 2, the film forming apparatus

100 of the first embodiment comprises: a turntable 1 of a spin coater on which an optical disc substrate 3 is to be placed; and a ring 2 which is to be placed on the optical disc substrate 3. The rotation shaft 1A of the turntable 1 has an outer diameter, which is slightly smaller than the inner diameter of an opening 3a, which is formed in the center of the optical disc substrate 3. The ring 2 has a cylindrical shape. The inner diameter of an opening 2a, which is formed in the center of the ring 2, is slightly larger than the rotation shaft 1A of the turntable 1. The ring 2 can be produced by using a metal such as aluminum or stainless steel (SUS), or various resins such as an acrylic resin, Derlin, a polycarbonate resin, a polypropylene resin, and a polyethylene resin.

[0013]

Next, the procedure of forming a cover layer on the optical disc substrate 3 by using the film forming apparatus 100 will be described. As shown in Fig. 1, the optical disc substrate 3 is placed on the turntable 1, and the ring 2 is placed on the optical disc substrate 3. At this time, both the opening 3a of the optical disc substrate 3 and the opening 2a of the ring 2 are engaged with the rotation shaft 1A of the turntable 1. Then, an ultraviolet curing resin 4 is dropped from a supply pipe 4a so as to be in contact with an outer peripheral face 2b of

the ring 2. At this time, as shown in Fig. 1(b), the ultraviolet curing resin 4 adheres to the outer peripheral face 2b so as to reach a position t, which is higher in level than the thickness a of a cover layer 4A, which will be finally formed. In order to control the film thickness so as to be uniform, therefore, the thickness d of the ring 2 is required not to be smaller than the thickness a of the cover layer 4A, which will be formed.

[0014]

Then, the turn table 1 is rotated at a high speed to spin off an excess amount of the ultraviolet curing resin 4, whereby a film of the ultraviolet curing resin 4 is formed on the surface of the optical disc substrate 3. Thereafter, the film of the ultraviolet curing resin 4 is irradiated with ultraviolet rays, so that the ultraviolet curing resin 4 cures to form the cover layer 4A. The amount of the ultraviolet curing resin 4, which is spun off by rotation of the turntable 1, may be recycled and reused.

[0015]

Fig. 3(a) is a view, which shows in the form of a graph an average film thickness of cover layers that were formed by using the film forming apparatus of the first embodiment, and Fig. 3(b) is a section view of the optical disc substrate and showing the cover layer. In Fig. 3(a), the ordinate indicates the thickness of the cover layer 4A

shown in Fig. 3(b), and the abscissa indicates the distance (radius) from the center of the optical disc substrate 3.

[0016]

The film formation was conducted under conditions that, after the ultraviolet curing resin 4 was dropped, the turn table 1 was rotated at 700 rpm for 60 seconds.

[0017]

As apparent from comparison with a comparative example, which will be described later, in the first embodiment, the film thickness in the inner peripheral side of the optical disc substrate 3 is not largely different from that in the outer peripheral side, and a film thickness which is more uniform is obtained over the entire area of the substrate 3.

[0018]

-Comparative example-

Fig. 12 shows an average film thickness in the case where the ring 2 in the first embodiment was not used, an ultraviolet curing resin was supplied to the same position as that in the first embodiment, and the same film forming conditions were employed.

[0019]

In the comparative example, as shown in Fig. 12, the film thickness in the inner peripheral side of the optical disc substrate is small, and that in the outer peripheral side is large, with the result that a uniform film

thickness cannot be obtained over the entire area of the substrate.

[0020]

-Second embodiment-

Hereinafter, a second embodiment of the film forming apparatus of the invention will be described with reference to Figs. 4 to 6. Fig. 4 is a section view showing the film forming apparatus of the second embodiment, Fig. 5(a) is a plan view of a ring as viewed from the top of Fig. 4, and Fig. 5(b) is a section view taken along line VB-VB of Fig. 5(a). The components identical with those of the first embodiment are denoted by the same reference numerals, and their description is omitted.

[0021]

In the film forming apparatus 200 of the second embodiment, a ring 21 is used in place of the ring 2 of the first embodiment. As shown in Figs. 4 and 5, the ring 21 has a substantially truncated conical shape, and the inner diameter of an opening 21a, which is formed in the center of the ring 21, is slightly larger than the outer diameter of the rotation shaft 1A of the turntable 1. An outer peripheral face 21b of the ring 21 is inclinedly formed so that the sectional area further increases as moving toward the face contacting with the optical disc substrate 3. The ring 21 can be produced by using a metal such as aluminum

or stainless steel (SUS), or various resins such as an acrylic resin, Derlin, a polycarbonate resin, a polypropylene resin, and a polyethylene resin.

[0022]

When a cover layer is to be formed on the optical disc substrate 3 by using the film forming apparatus 200, the ultraviolet curing resin 4 is dropped so as to be in contact with the outer peripheral face 21b of the ring 21. The other steps and the conditions for rotation of the turn table 1 are identical with those of the first embodiment. The ultraviolet curing resin 4 adheres to the outer peripheral face 21b so as to reach a position, which is higher in level than the thickness of a cover layer, which will be finally formed. In order to control the film thickness so as to be uniform, therefore, the ring 21 is required not to be thinner than the cover layer, which will be formed.

[0023]

Fig. 6 is a view, which shows in the form of a graph an average film thickness of cover layers that were formed by using the film forming apparatus of the second embodiment. In Fig. 6, the ordinate indicates the thickness of the cover layer, and the abscissa indicates the distance (radius) from the center of the optical disc substrate 3.

[0024]

As apparent from comparison with the comparative example, in the second embodiment, the film thickness in the inner peripheral side of the optical disc substrate 3 is not largely different from that in the outer peripheral side, and a film thickness, which is more uniform, is obtained over the entire area of the substrate 3.

[0025]

-Third embodiment-

Hereinafter, a third embodiment of the film forming apparatus of the invention will be described with reference to Figs. 7 and 8. Fig. 7 is a section view showing the film forming apparatus of the third embodiment, Fig. 8(a) is a plan view of a film forming jig as viewed from the top of Fig. 7, and Fig. 8(b) is a section view taken along line VIIIB-VIIIB of Fig. 8(a). The components identical with those of the second embodiment are denoted by the same reference numerals, and their description is omitted.

[0026]

In the film forming apparatus 300 of the third embodiment, a film forming jig 22 is used in place of the ring 21 of the second embodiment. As shown in Figs. 7 and 8, the film forming jig 22 has a substantially conical shape having a vertex 22c, and the inner diameter of a hole 22a, which is formed in the center of the film forming jig

22, is slightly larger than the outer diameter of the rotation shaft 1A of the turntable 1. An outer peripheral face 22b of the film forming jig 22 is inclinedly formed so as to become wider as moving toward the face contacting with the optical disc substrate 3. A face 22d corresponding to a lower face of the cone is in contact with the surface of the optical disc substrate 3. The film forming jig 22 can be produced by using a metal such as aluminum or stainless steel (SUS), or various resins such as an acrylic resin, Derlin, a polycarbonate resin, a polypropylene resin, and a polyethylene resin.

[0027]

When a cover layer is to be formed on the optical disc substrate 3 by using the film forming apparatus 300, the ultraviolet curing resin 4 is dropped so as to be in contact with the outer peripheral face 22b of the film forming jig 22. Since the film forming jig 22 has a substantially conical shape, the ultraviolet curing resin 4 which has been once dropped on the outer peripheral face 22b downward moves along the outer peripheral face 22b to a position contacting with the optical disc substrate 3. Therefore, the dropping position of the resin 4 may be changed to a position which is located more inward than that in the second embodiment.

[0028]

When the other steps and the conditions for rotation of the turn table 1 are set to be identical with those of the second embodiment, it is possible to attain the same result as that of the second embodiment.

[0029]

-Fourth embodiment-

Hereinafter, a fourth embodiment of the film forming apparatus of the invention will be described with reference to Figs. 9 to 11. Fig. 9 is a section view showing the film forming apparatus of the fourth embodiment, Fig. 10(a) is a plan view of a ring as viewed from the top of Fig. 9, and Fig. 10(b) is a section view taken along line XB-XB of Fig. 10(a). The components identical with those of the first embodiment are denoted by the same reference numerals, and their description is omitted.

[0030]

In the film forming apparatus 400 of the fourth embodiment, a ring 23 is used in place of the ring 2 of the first embodiment. As shown in Figs. 9 and 10, the ring 23 has a substantially truncated conical shape, and the inner diameter of an opening 23a, which is formed in the center of the ring 23, is slightly larger than the outer diameter of the rotation shaft 1A of the turntable 1. An outer peripheral face 23b of the ring 23 is inclinedly formed so that the sectional area is further increased as moving

toward the face contacting with the optical disc substrate 3. The ring 23 can be produced by using a metal such as aluminum or stainless steel (SUS), or various resins such as an acrylic resin, Derlin, a polycarbonate resin, a polypropylene resin, and a polyethylene resin.

[0031]

When a cover layer is to be formed on the optical disc substrate 3 by using the film forming apparatus 400, the ultraviolet curing resin 4 is dropped so as to be in contact with the outer peripheral face 23b of the ring 23. The other steps and the conditions for rotation of the turn table 1 are identical with those of the first embodiment. The ultraviolet curing resin 4 adheres to the outer peripheral face 23b so as to reach a position, which is higher in level than the thickness of a cover layer, which will be finally formed. In order to control the film thickness so as to be uniform, therefore, the ring 23 is required not to be thinner than the cover layer, which will be formed.

[0032]

Fig. 11 is a view, which shows in the form of a graph an average film thickness of cover layers that were formed by using the film forming apparatus of the fourth embodiment. In Fig. 11, the ordinate indicates the thickness of the cover layer, and the abscissa indicates

the distance (radius) from the center of the optical disc substrate 3.

[0033]

As apparent from comparison with the comparative example, in the fourth embodiment, the film thickness in the inner peripheral side of the optical disc substrate 3 is not largely different from that in the outer peripheral side, and a film thickness, which is more uniform, is obtained over the entire area of the substrate 3.

[0034]

The invention is not limited to the embodiments. In place of the turntable, rotating means for sucking the surface of the substrate from above the substrate and rotating the substrate may be used.

[0035]

For example, the control may not be performed so as to uniformalize the film thickness, but may be performed so that the film thickness in the inner peripheral side of the substrate is larger than that of another portion.

[0036]

In place of the ultraviolet curing resin, a thermosetting resin may be used.

[0037]

The outer peripheral face of the film forming jig may be configured as a curved face, or the film forming jig may

have a substantially cylindrical shape, a substantially conical shape, a substantially truncated conical shape, a substantially hemispherical shape, or the like.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a view showing a film forming apparatus of a first embodiment in which Fig. 1(a) is a section view showing the film forming apparatus of the first embodiment, and Fig. 1(b) is a partial enlarged section view of Fig. 1(a).

[Fig. 2]

Fig. 2 is a view showing a ring, and Fig. 2(a) is a plan view of the ring as viewed from the top of Fig. 1, and Fig. 2(b) is a section view taken along line B-B of Fig. 2(a).

[Fig. 3]

Fig. 3 is a view showing a formed cover layer in which Fig. 3(a) is a view which shows in the form of a graph an average film thickness of cover layers that were formed by using the film forming apparatus of the first embodiment, and Fig. 3(b) is a section view showing the cover layer.

[Fig. 4]

Fig. 4 is a section view showing a film forming apparatus of a second embodiment.

[Fig. 5]

Fig. 5 is a view showing a ring, and Fig. 5(a) is a plan view of the ring as viewed from the top of Fig. 4, and Fig. 5(b) is a section view taken along line VB-VB of Fig. 5(a).

[Fig. 6]

Fig. 6 is a view, which shows in the form of a graph an average film thickness of cover layers that were formed by using the film forming apparatus of the second embodiment.

[Fig. 7]

Fig. 7 is a section view showing a film forming apparatus of a third embodiment.

[Fig. 8]

Fig. 8 is a view showing a film forming jig, and Fig. 8(a) is a plan view of the film forming jig as viewed from the top of Fig. 7, and Fig. 8(b) is a section view taken along line VIIIB-VIIIB of Fig. 8(a).

[Fig. 9]

Fig. 9 is a section view showing a film forming apparatus of a fourth embodiment.

[Fig. 10]

Fig. 10 is a view showing a ring, and Fig. 10(a) is a plan view of the ring as viewed from the top of Fig. 9, and Fig. 10(b) is a section view taken along line XB-XB of Fig. 10(a).

[Fig. 11]

Fig. 11 is a view which shows in the form of a graph an average film thickness of cover layers that were formed by using the film forming apparatus of the fourth embodiment.

[Fig. 12]

Fig. 12 is a view which shows in the form of a graph film thicknesses of cover layers in a comparative example.

[Description of the Reference Numerals and Signs]

1 turntable
1A rotation shaft
2 ring (film forming jig)
2b outer peripheral face
3 optical disc substrate (substrate)
3a opening
4 ultraviolet curing resin (film forming liquid)
4A cover layer (film)
21 ring (film forming jig)
21b outer peripheral face
22 film forming jig
22b outer peripheral face
22d face (lower face)
23 ring (film forming jig)
23b outer peripheral face

[Designation of Document] ABSTRACT

[Abstract]

[Problem] A film forming apparatus and a film forming method in which a film can be formed while controlling the thickness of the film are provided.

[Means for Resolution] The film forming apparatus has: a turntable 1; and a film forming jig 2 which is to be placed on a substrate 3 positioned on the turn table 1, wherein a cover layer 4A is formed on the optical disc substrate 3 by rotating the turn table 1 under a state where an ultraviolet curing resin 4 is supplied so as to be in contact with an outer periphery of the film forming jig 2.

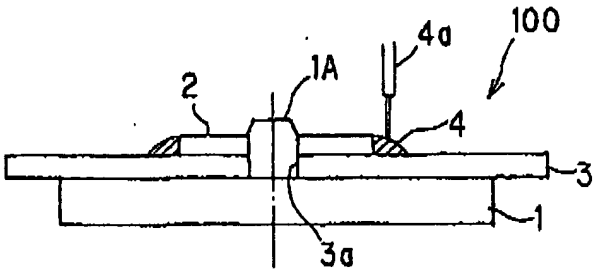
[Selected Figure] Fig. 1

【~~書類名~~】 ~~図面~~ Drawings

【~~図1~~】 Designation of Document

Fig. 1

(a)



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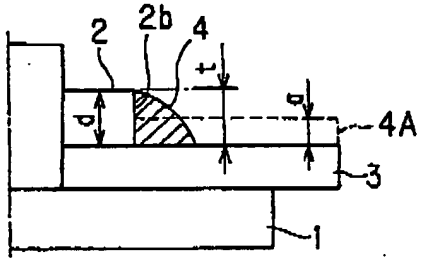
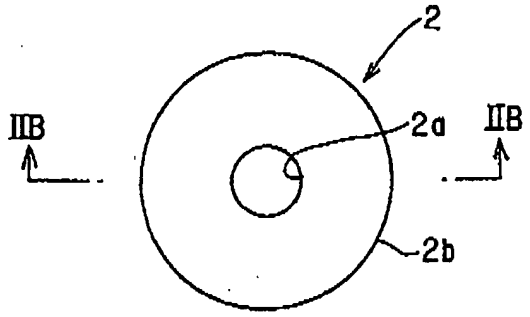


【~~図2~~】

Fig. 2

(a)



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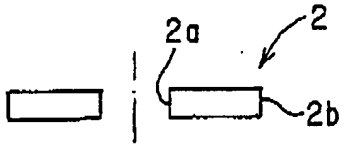
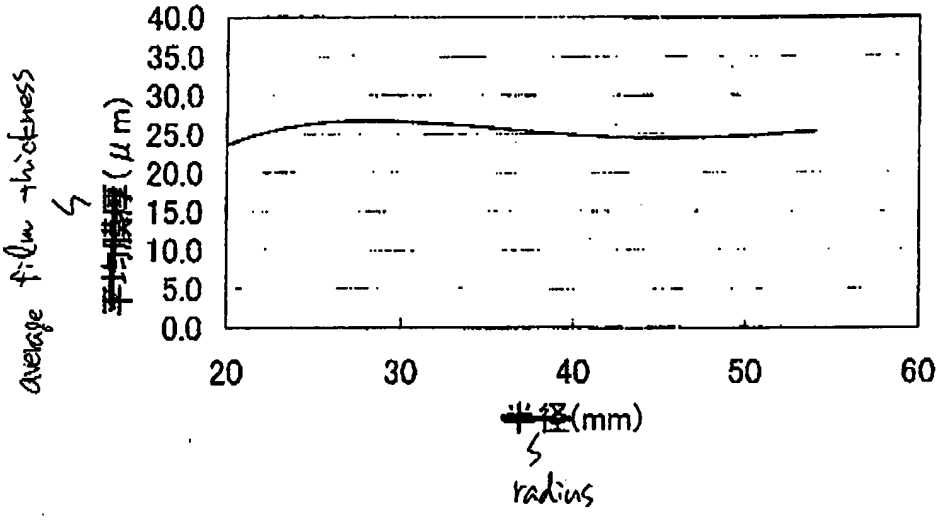


【~~図3~~】

Fig. 3

(a)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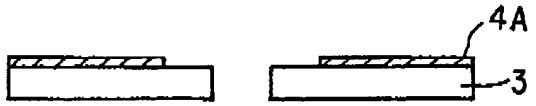
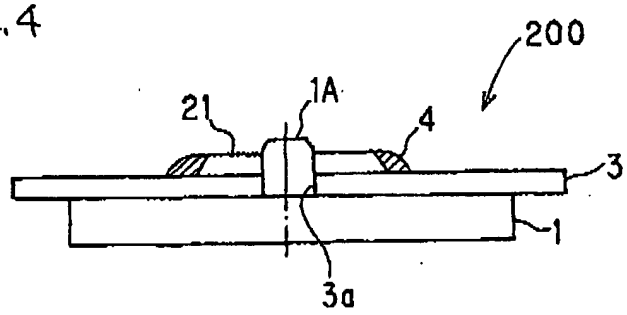
average film thickness
~~半径~~(mm)
radius

(b)


4A
3

【~~図４~~】

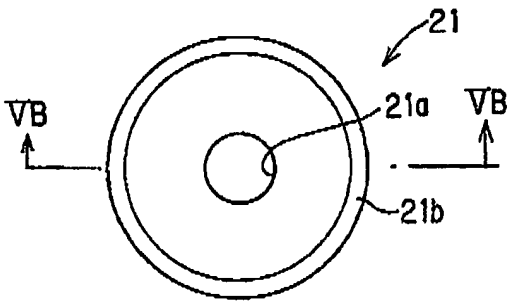
Fig.4



【~~図５~~】

Fig.5

(a)



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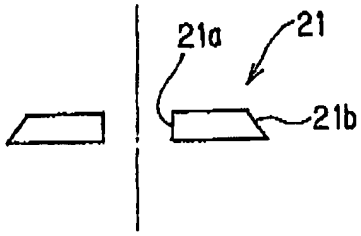

【図6】

Fig.6

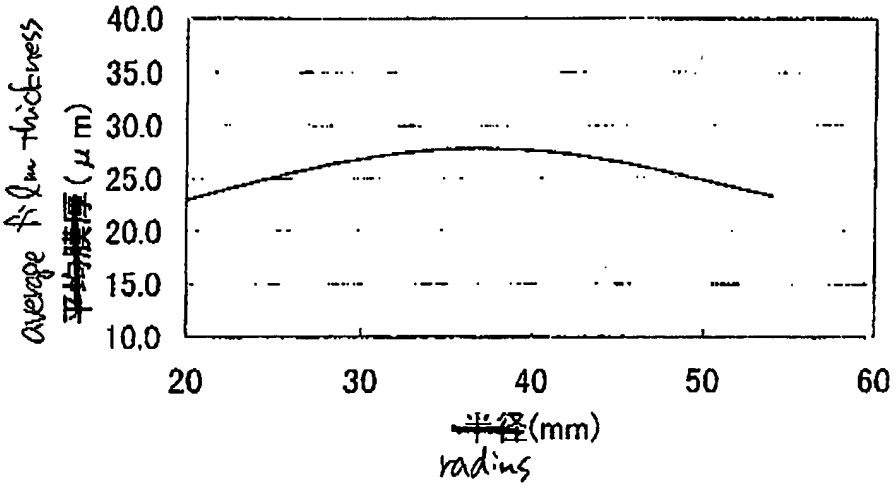

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Fig.7

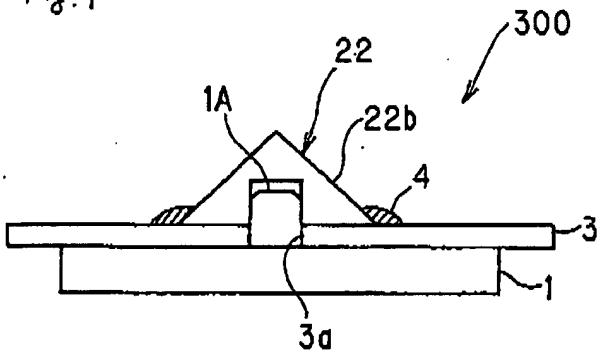

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Fig. 8

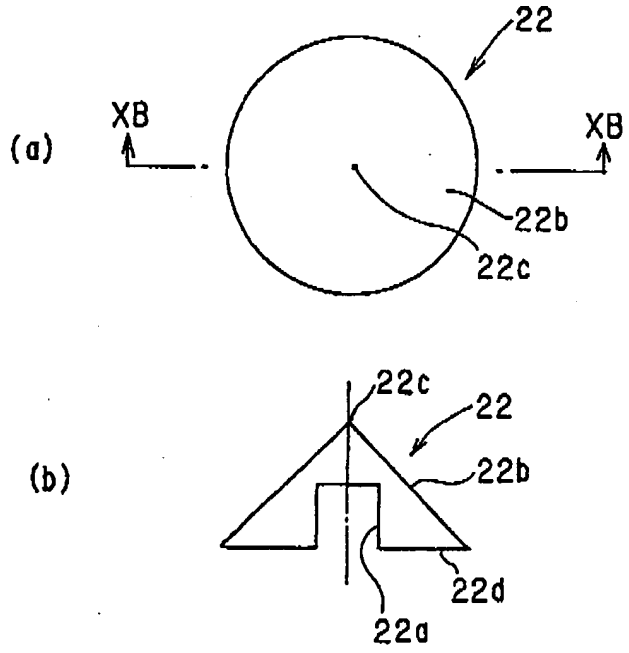

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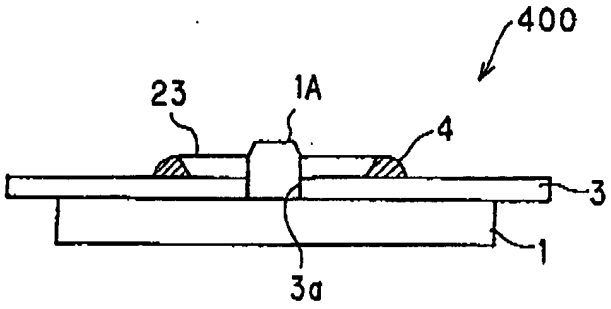
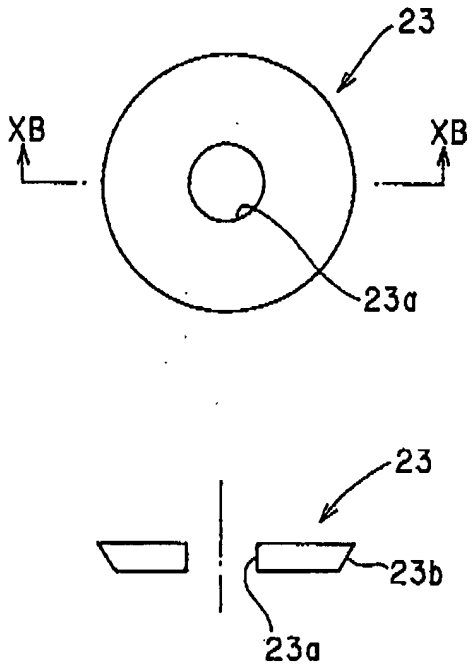
Fig. 9



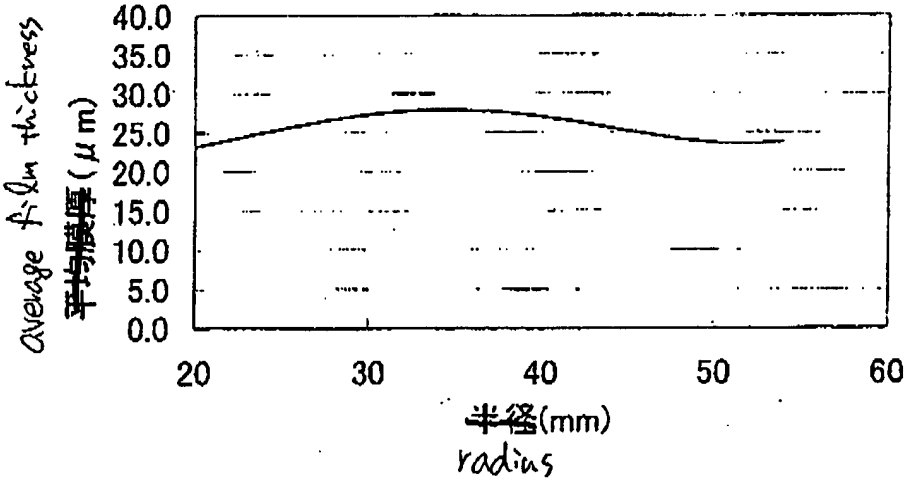
【~~図１０~~】

Fig. 10



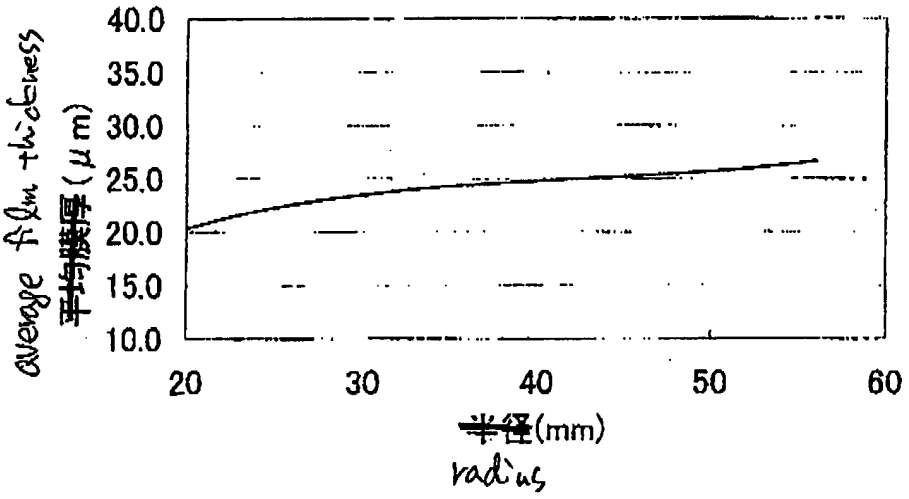
【~~図１１~~】

Fig. 11



【~~図１２~~】

Fig. 12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50
60
~~半径~~(mm)
radius